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THE INTRODUCTION OF FOREIGN WEEDS IN BALLAST AS ILLUSTRATED BY BALLAST-PLANTS AT LINNTON, OREGON

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One of the striking features of the flora of that part of Oregon lying west of the Cascade Mountains is the very large proportion of introduced plants which have become fully established. Many foreign plants which are common in the Eastern States, but which disappear wholly or largely in the Central States and the Great Plains, reappear on the Pacific coast. The high humidity and mild winters of this region afford exceptionally favorable conditions for the propagation of these immigrants, and make it difficult to eradicate them when once established. The similarity of climatic conditions to those of Western Europe has enabled a very large number of plants indigenous to that region to obtain a foothold in western Oregon. Mr. John Burroughs has called attention to the surprising tenacity of the plants and animals of the British Isles when forced to struggle for existence with our native species. Unfortunately the plants which tend to survive in this contest are most often those which are not only of no value, but are a positive menace to the farmer and stockman. The vilest and most obnoxious weeds seem specially favored in the struggle, and spread with such surprising facility that under the prevailing methods of cultivation it is impossible to make head against them.

The precise agency by which these foreign plants are first introduced cannot usually be determined with any certainty. They are often encountered for the first time in regions remote

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from the ordinary routes of travel, and are mistaken by the collector for genuine indigenes. From these original stations they have spread with such rapidity that it has been very difficult for the few collectors scattered over this vast area to keep pace with them. I hope at some future time to present a somewhat exhaustive study of these introduced members of the flora of Oregon. In the present paper I desire to confine myself to calling attention to one of the "ports of entry" for these immigrants, and to show in what numbers they are finding lodgment on our soil at that point.

Every student of plant-life who has collected near the coast has observed what a prolific field for the introduction of new species is afforded by the heaps of ballast-material that are found in the neighborhood of the larger seaports. For one season at least, species from all parts of the world are mingled in wild confusion. Those indigenous to the tropics usually do not survive their first winter, and many others are mere waifs, appearing perhaps in considerable abundance for a single season, but disappearing entirely after their first flowering. Many others, however, more tenacious of life, or with vegetative organs better adapted to the struggle with new and adverse conditions, become fully established, and from the original point of introduction rapidly distribute themselves to all parts of the neighboring region. Several distributing points of this sort occur about the ports of the Pacific coast; and it has been my good fortune during the past two seasons to study one of the most interesting of these ballast-grounds. Lying along the left bank of the Willamette River at Linnton, seven miles from the heart of the city of Portland, and covering an area of some 40,000 square yards between the river and the tracks of the North Bank Railroad, is an old ballast-dump, now little used, that has remained undisturbed long enough to become covered with a dense growth of vegetation, nearly all of which is foreign, though near the edges a few native species have gained a footing. Many different "strata" of ballast can still be traced, and each has its own characteristic flora, though the more vigorous species have spread indiscriminately over the entire area. Much of

the original material is sand, mixed with gravel and loam; and the decaying remains of many seasons' growth have spread a layer of humus over all parts except those nearest the river, where an occasional vessel still deposits fresh material. A few belts of crushed obsidian have successfully resisted the inroads of the invaders, and afford access to the center of the tangle. The very large proportion of plants bearing burs or prickles makes the task of the collector far from pleasant.

In the last two seasons I have made six trips to Linnton, on August 28 and October 9, 1915, and June 17, July 29, September 2, and October 14, 1916. I have made notes on all the plants that I have observed, and brought home specimens of all that were unfamiliar. In many cases I have found it impossible, with the limited herbarium and library resources at my command, to determine or even make a guess at their identity. I must express my obligations to the staff of the Gray Herbarium of Harvard University, to Mrs. Agnes Chase, of the U. S. Dept. of Agriculture, and to Mr. Kenneth K. Mackenzie, of New York City, for their kindness in determining these puzzling species. Specimens of practically all the species that have not been heretofore reported from Oregon have been deposited either in the Gray or the National Herbarium.

The fact that each successive visit has brought to light species not observed on previous visits, convinces me that the following list is far from being complete, and that another season will add materially to the number. Students will observe that while many plants in this list are familiar everywhere, a large proportion of the total is made up of species whose occurrence at a point so remote from their original range is deserving of remark. In many cases these unfamiliar visitors are the plants most solidly established, and showing the greatest likelihood of becoming permanent residents. Very few of them, unfortunately, can be regarded as welcome additions to our flora, or as tending in any way to be beneficial. It is fortunate that the region about Linnton is not an agricultural one; otherwise it might be a wise provision on the part of the state to extirpate the entire area.

In presenting the following list, which is to be regarded as

including every species collected on the Linnton area that was capable of determination, I have tried to follow as far as possible the order of families and genera as accepted in Gray's Manual, and to use the nomenclature of the Vienna Code. The list may be divided into three groups: (1) those that are indigenous to the Pacific coast, and which have probably invaded the ballast-ground from the surrounding territory, although in the case of a few of them I strongly suspect they were brought in in ballast; (2) those that, although introduced, are found elsewhere in Oregon. Whether these were originally brought to Linnton in ballast, or found their way in from the surrounding neighborhood, cannot in most cases be determined with any certainty; (3) those that I have found only on the Linnton area. Some of this last group will probably be transferred to group (2) by other collectors; but as far as my own experience goes, I have not found them at any other station. A few species that on account of the immaturity of the specimens could not be determined with any certainty are added at the end.

GROUP 1. SPECIES INDIGENOUS ON THE PACIFIC COAST

1. *Pteris aquilina* L., var. *pubescens* Clute. Our commonest fern—locally a bad weed.
2. *Equisetum arvense* L. Common throughout.
3. *Phalaris arundinacea* L. Not common in the Willamette Valley.
4. *Alopecurus aristulatus* Michx. Not uncommon in wet places.
5. *Agrostis alba* L., var. *maritima* (Lam.) Mey. Common along the coast.
6. *Deschampsia elongata* (Hook.) Munro. Very common.
7. *Distichlis spicata* (L.) Greene. Common along the coast.
8. *Poa Sandbergii* Vasey. It is hard to explain the presence of this species.
9. *Poa triflora* Gilib. As far as the Pacific coast is concerned, I suspect this should be regarded as introduced.
10. *Festuca megalura* Nutt. Very common—appears as if introduced.
11. *Festuca rubra* L. Perhaps introduced here, but undoubtedly indigenous in many places.
12. *Bromus carinatus* Hook. & Arn. Abundant.
13. *Hordeum jubatum* L. Probably introduced, but indigenous in other localities.
14. *Elymus glaucus* Buckl. Very common.
15. *Rumex occidentalis* Wats. Common near the coast.
16. *Spergularia rubra* (L.) J. & C. Presl.
17. *Spergularia marina* (L.) Griseb. Both perhaps introduced.
18. *Eschscholzia californica* Cham. Very common.
19. *Lepidium apetalum* Willd. Common in the interior.
20. *Rubus macropetalus* Dougl. An evident invasion from the neighborhood.

21. *Acer macrophyllum* Pursh. Not mature.
22. *Epilobium adenocaulon* Haussk. Very common.
23. *Epilobium angustifolium* L. Very common.
24. *Gilia capitata* Hook. Very common.
25. *Symphoricarpos albus* L. Blake. Common in wooded districts.
26. *Solidago lepida* DC. Indigenous northward.
27. *Aster Douglasii* Lindl. Abundant.
28. *Anaphalis margaritacea* (L.) Benth. & Hook. Abundant.
29. *Gnaphalium purpureum* L. Occasional in low ground.
30. *Franseria bipinnatifida* Nutt. Common along the coast.
31. *Artemisia Tilesii* Ledeb. Indigenous northward and in the mountains.
32. *Hieracium canadense* Michx. Very rare.

GROUP 2. INTRODUCED SPECIES OCCURRING ELSEWHERE IN OREGON

33. *Digitaria sanguinalis* (L.) Scop. Beginning to appear in lawns.
34. *Phleum pratense* L. A common escape.
35. *Agrostis alba* L. Very common.
36. *Polygonum monspeliensis* (L.) Desf. Not infrequent.
37. *Holcus lanatus* L. One of our commonest grasses.
38. *Avena sativa* L. A common escape.
39. *Cynodon Dactylon* L. Scarce; rarely flowers in other localities.
40. *Dactylis glomerata* L. Very common.
41. *Poa annua* L. Abundant on lawns and in waste places.
42. *Poa compressa* L. Common in dry soil.
43. *Poa pratensis* L. A common escape.
44. *Bromus hordeaceus* L. Very common.
45. *Bromus marginatus* Nees. Perhaps the same as No. 12.
46. *Bromus rubens* L. Rare in waste places.
47. *Bromus secalinus* L. Very common.
48. *Bromus tectorum* L. Rare in waste places.
49. *Bromus villosus* Forsk. Not infrequent.
50. *Lolium multiflorum* Lam. Very common.
51. *Lolium perenne* L. With the last, and equally common.
52. *Hordeum murinum* L. Very common about towns.
53. *Triticum vulgare* L. A common escape.
54. *Asparagus officinalis* L. Rather infrequent.
55. *Rumex Acetosella* L. Very abundant—a pernicious weed.
56. *Rumex conglomeratus* Murr. Infrequent.
57. *Rumex crispus* L. Abundant.
58. *Rumex obtusifolius* L. Common about dwellings.
59. *Polygonum aviculare* L. Abundant in door-yards, etc.
60. *Polygonum Convolvulus* L. Common in cultivated ground.
61. *Polygonum Hydropiper* L. Common in low ground.
62. *Polygonum Persicaria* L. Abundant.
63. *Chenopodium album* L. A troublesome garden weed.
64. *Chenopodium ambrosioides* L. Occasional on sand-bars along the Willamette.
65. *Salsola Kali* L., var. *tenuifolia* Mey. Beginning to appear in waste ground.
66. *Spergula arvensis* L. Common in cultivated ground.

67. *Stellaria media* L. Abundant.
68. *Cerastium viscosum* L. Common in cultivated ground.
69. *Saponaria Vaccaria* L. Rare in waste places.
70. *Ranunculus repens* L. Occasional in lawns and meadows.
71. *Lepidium perfoliatum* L. Beginning to appear in waste places.
72. *Capsella Bursa-pastoris* (L.) Medic. Abundant everywhere.
73. *Raphanus sativus* L. A common escape.
74. *Brassica arvensis* (L.) Ktze. Common.
75. *Brassica campestris* L. Common.
76. *Sisymbrium altissimum* L. Becoming common.
77. *Pyrus Malus* L. A frequent escape.
78. *Rosa rubiginosa* L. Very common.
79. *Prunus Persica* (L.) Stokes. An occasional escape.
80. *Ulex europaeus* L. Rare elsewhere.
81. *Trifolium hybridum* L. A frequent escape.
82. *Trifolium pratense* L. Very common.
83. *Trifolium procumbens* L. Occasional in waste places.
84. *Trifolium repens* L. Abundant.
85. *Melilotus alba* Desr. Common on roadsides.
86. *Melilotus officinalis* (L.) Lam. Infrequent in waste places.
87. *Medicago hispida* Gaertn. Common in waste places.
88. *Medicago sativa* L. A common escape.
89. *Erodium cicutarium* (L.) L'Her. Abundant in fields.
90. *Hypericum perforatum* L. One of our worst weeds.
91. *Conium maculatum* L. Occasional about towns.
92. *Foeniculum vulgare* Hill. Abundant about Salem.
93. *Anagallis arvensis* L. Occasional in cultivated ground.
94. *Convolvulus arvensis* L. Common along railroad tracks.
95. *Marrubium vulgare* L. Not uncommon in waste places.
96. *Melissa officinalis* L. Abundant about towns.
97. *Solanum nigrum* L., var. *villosum* L. Beginning to appear on sandbars along the Willamette River.
98. *Verbascum Thapsus* L. Common in dry soil.
99. *Verbascum Blattaria* L. Commoner than the last.
100. *Linaria vulgaris* Hill. Infrequent.
101. *Plantago lanceolata* L. One of our commonest weeds.
102. *Plantago major* L. Very common.
103. *Erigeron canadensis* L. Common.
104. *Achillea Millefolium* L. Very common.
105. *Anthemis arvensis* L. Infrequent.
106. *Matricaria suaveolens* (Pursh) Buch. Abundant in waste places.
107. *Chrysanthemum Leucanthemum* L. var. *pinnatifidum* Lecoq. & Lamotte. Common in meadows.
108. *Tanacetum vulgare* L. An occasional escape.
109. *Senecio sylvaticus* L. Becoming common, especially near the coast.
110. *Arctium minus* Bernh. An abundant and pernicious weed.
111. *Cirsium arvense* (L.) Scop. Too common. A vile weed.
112. *Cirsium lanceolatum* (L.) Hill. Very common.
113. *Centaurea melitensis* L. Common in southern Oregon.

114. *Cichorium Intybus* L. A common escape.
 115. *Hypochaeris radicata* L. Abundant everywhere.
 116. *Sonchus asper* (L.) Hill. Infrequent.
 117. *Sonchus oleraceus* L. Common in cultivated ground.
 118. *Lactuca Scariola* L. Much less common than the variety.
 119. *Lactuca Scariola* L., var. *integrata* Gren. & Godr. One of our worst weeds.
 120. *Crepis capillaris* (L.) Wallr. Abundant everywhere.

GROUP 3. SPECIES COLLECTED ONLY ON THE LINNONTON BALLAST-AREA

121. *Paspalum dilatatum* Poir. Did not survive first season.
 122. *Panicum barbinode* Trin. Did not flower, and was winter-killed.
 123. *Setaria imberbis* (Poir.) R. & S. Indigenous eastward, but doubtless introduced here from Trop. America.
 124. *Cenchnus carolinianus* Walt. Same note as the last.
 125. *Phalaris brachystachys* Link. Found also in California.
 126. *Phalaris minor* Retz. Reported from Vancouver Island.
 127. *Phalaris paradoxa* L., var. *praemorsa* Coss. & Dur. Found also in California.
 128. *Stipa littoralis* Philippi. A Chilean species, not before reported from United States.
 129. *Nassella chilensis* Desv. Not found second season.
 130. *Alopecurus agrestis* L. Reported from the Dalles.
 131. *Agrostis stolonifera* L. Reported by other collectors from various points.
 132. *Polygonum littoralis* (With.) Sm. Reported from the coast of southern Oregon.
 133. *Ammophila arenaria* Link. Established about San Francisco.
 134. *Chloris radiata* Sw. A South American species, not before reported from Oregon.
 135. *Eleusine indica* Gaertn. Said to occur occasionally.
 136. *Eleusine tristachya* Kunth. A South American species, not before reported from Oregon.
 137. *Eragrostis cyperoides* (Thunb.) Beauv. A South African species, not before reported from the United States; not found second season.
 138. *Eragrostis Orcuttiana* Vasey. Indigenous in California, but not maritime; not found second season.
 139. *Bromus inermis* Leyss. Common in cultivation further east, but I have no report of it from Oregon.
 140. *Lepturus incurvatus* Trin. Reported from California.
 141. *Agropyron pungens* (Pers.) R. & S. A species from the north of Europe, not previously reported from Oregon.
 142. *Agropyron repens* (L.) Beauv. Said to occur occasionally west of the Cascades; abundant eastward.
 143. *Agropyron glaucum* R. & S. Not previously reported from Oregon.
 144. *Agropyron junceum* Beauv. Reported from California.
 145. *Hordeum maritimum* With. Same note as last.
 146. *Cyperus ferox* Rich. Not found second season.
 147. *Cyperus kyllingueoides* Vahl. An Asiatic species; found second season only.
 148. *Carex arenaria* L. Not before reported from Oregon.
 149. *Carex hirta* L. Same note as last.
 150. *Urtica dioica* L. Same note as last.

151. *Rumex cuneifolius* Camp. A Patagonian species—probably its first occurrence in the United States.
152. *Roubieva multifida* Moq. Not before reported from Oregon.
153. *Chenopodium murale* L. Said to occur along the Columbia River.
154. *Atriplex patula* L., var. *hastata* (L.) Gray. Said to occur in the interior.
155. *Spinacia oleracea* Mill. Common in cultivation.
156. *Amaranthus gracilis* Desf. A tropical species, not before reported from Oregon.
157. *Tetragonia expansa* Murr. Probably introduced from China.
158. *Mesembryanthemum crystallinum* L. Reported from California.
159. *Mesembryanthemum nodiflorum* Haw. Not before reported from Oregon.
160. *Polycarpon tetraphyllum* L. Not before reported from Oregon; found second season only.
161. *Papaver Argemone* L. Reported from Seattle.
162. *Papaver dubium* L. Not before reported from Oregon.
163. *Lepidium medium* Greene. Reported by other collectors from various points.
164. *Lepidium Draba* L. Same note as the last.
165. *Lepidium Draba* L., subsp. *chalepense* Thell. Not before reported from Oregon.
166. *Lepidium graminifolium* L. Same note as the last.
167. *Lepidium virginicum* L., subsp. *texanum* (Buckl.) Thell. Same note as last.
168. *Lepidium reticulatum* How. This needs further study. Howell's species was indigenous.
169. *Coronopus didymus* (L.) Sm. Has been reported from other stations.
170. *Camelina microcarpa* Andrz. Reported from Vancouver Island.
171. *Brassica incana* F. W. Schultz. Becoming a bad weed in California.
172. *Diplotaxis tenuifolia* DC. Not before reported from Oregon.
173. *Sisymbrium officinale* (L.) Scop. Reported from other stations.
174. *Reseda lutea* L. Not before reported from Oregon.
175. *Reseda Luteola* L. Same note as the last.
176. *Rubus fruticosus* L. Same note as the last.
177. *Mimosa asperata* L. A Mexican species; did not survive first season.
178. *Trifolium arvense* L. Reported from other stations.
179. *Medicago lupulina* L. Same note as the last.
180. *Ononis arvensis* L. Not before reported from Oregon.
181. *Anthyllis Vulneraria* L. Same note as the last.
182. *Lotus corniculatus* L. Same note as last.
183. *Cononilla varia* L. Same note as last.
184. *Vicia angustifolia* (L.) Reichard, var. *segetalis* (Thuill.) Koch. Same note as last.
185. *Erodium moschatum* (L.) L'Her. Reported from other stations.
186. *Corchorus pilobolus* Link. Not before reported from Oregon.
187. *Modiola caroliniana* (L.) G. Don. Same note as last.
188. *Lythrum Hyssopifolia* L. Reported from other stations.
189. *Oenothera mollissima* L. A South American species, not before reported from Oregon.
190. *Cochranea anchusaefolia* (Poir.) Gurke. Not before reported from Oregon.
191. *Verbena officinalis* L. I have since found this around buildings at St. Paul, Oregon.

192. *Solanum nigrum* L., var. *Douglasii* Gray. Not before reported from Oregon.
 192. *Solanum sisymbriifolium* Lam. Reported from other stations.
 194. *Datura villosa* Fernald. A Mexican species, not before reported from Oregon.
 195. *Nicotiana rustica* L. Did not survive first season.
 196. *Plantago Coronopus* L. Not before reported from Oregon. Found second season only.
 197. *Galium verum* L. Had been reported from Salem.
 198. *Acanthospermum australe* (Loefl.) Ktze. Not before reported from Oregon.
 199. *Ambrosia tenuifolia* Spreng. A tropical species; not found second season.
 200. *Xanthium speciosum* Kearn. Indigenous in various western stations, but plainly introduced here.
 201. *Xanthium spinosum* L. Reported from other stations.
 202. *Hemizonia pungens* (Hook. & Arn.) Torr. & Gray, var. *Parryi* (Greene) Hall. Indigenous in California.
 203. *Matricaria inodora* L. Reported from central Washington.
 204. *Cotula australis* Hook. Reported from California and southern Oregon.
 205. *Artemisia vulgaris* L. Not before reported from Oregon.
 206. *Arctotis calendulacea* L. Not found second season.
 207. *Senecio Jacobaea* L. Not before reported from Oregon.
 208. *Senecio viscosus* L. Same note as above.
 209. *Carduus crispus* L. Same note as the last.
 210. *Carduus nutans* L. Same note as the last.
 211. *Silybum marianum* (L.) Gaertn. Reported from other stations.
 212. *Centaurea Calcitrapa* L. Reported from other stations.
 213. *Centaurea consimilis* Boreau. Reported from eastern Washington.

In addition to the above, the following were collected, but on account of the imperfect state of the material—lack of fruit or flowers, or both—could not be satisfactorily determined:

214. *Salix* spp.—two forms; not in flower. One had the golden-yellow bark of *S. alba*, the other seemed a native form.
 215. *Potentilla* sp. A creeping form, without flowers. Perhaps *P. reptans* L.
 216. *Rosa* sp. In fruit only. Resembling *R. rubiginosa*, but much larger.
 217. *Desmodium* sp. Not in flower. A prostrate form.
 218. *Scrophularia* sp. In fruit. Capsules very small.
 219. *Sambucus* sp. Not in flower. Probably one of the native species.
 220. *Cucurbita* sp. Not in flower. Apparently one of the cultivated species.
 221. A prickly Composite with yellow flowers, suggesting *Cousinia*, that baffled all attempts at identification.
 222. A plant with immense prickly cut-toothed woolly leaves forming a rosette on the sand, without flowers. A probable Composite, possibly of the Thistle tribe.

Of the 213 identified species listed above, it will be seen that 32, or 15 per cent of the whole, are indigenous; 88, or 42 per cent, are introduced, but are not restricted to the Linnton area;

and 93, or 43 per cent, I have found only at Linnton, though at least 31 of these have been reported by other collectors from different points in the west. Perhaps it would be safe to say that 50 species of the above list have been collected for the first time on the Pacific coast, or at least within the limits of the state of Oregon.

PLEISTOCENE PLANTS IN THE MARINE CLAYS OF MAINE

BY EDWARD W. BERRY

The marine clays and associated sands of late Pleistocene age so widely distributed in northern New England and the St. Lawrence Valley and which in a large measure suggested the Champlain stage of the Pleistocene adopted by Dana in the first edition of his Manual have been the occasion of a considerable literature from the days of Desor down to the present.

These deposits occur at varying heights above the present sea level up to an altitude of 690 feet according to the recent determinations of Johnston.* Most observers have assumed that these deposits, commonly differentiated into "Saxicava sands" above and "Leda clays" below, could be correlated with precision over this area, often on the basis of lithology alone. That this is not true and that each locality must be considered separately in its relation to topography, physical history, adjacent glacial deposits and fossil content should be obvious. Recently Katz and Keith† have described the Newington Moraine and mapped it from near Portland, Maine, to Newburyport, Mass. This moraine is correlated with the late Wisconsin and the authors cited present evidence to show that it was submarine in origin and contemporaneous with that part of the so-called Leda clay of that region lying seaward of the moraine while the clay lying inside the moraine is younger. On the other hand Little,‡ who has been making a study of the Waterville (Maine) region

* Johnston, W. A., Can. Geol. Surv. Mus. Bull. No. 24, p. 5, 1916.

† Katz, F. J., and Keith, Arthur, U. S. Geol. Survey Prof. Paper 108B, pp. 11-29, 1917.

‡ Little, H. P., Bull. Geol. Soc. Am. (in press).